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# Impact of Water Supply Quality for Residents in Rio de Janeiro State, Brazil, during the COVID-19 Pandemic †

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**Abstract:** In Brazil, especially in the State of Rio de Janeiro, an environmental, health and humanitarian crisis is becoming evident due to the water supply crisis in the region. Therefore, the aim of this study was to evaluate the perception of consumers regarding the quality of water in the State of Rio de Janeiro, during the COVID -19 pandemic. A survey was conducted with 289 participants, who were residents of the State of Rio de Janeiro, after approval by the Research Ethics Committee of Federal University of the State of Rio de Janeiro (UNIRIO), from 26–30 of April 2021. Of the respondents, 40.83% reported that the drinking water is of low quality.

**Keywords:** water; Rio de Janeiro; Brazil



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## 1. Introduction

Access to safe and clean water is a right for everyone and essential for human health and life. As advocated by the United Nations, it is Sustainable Development Goal number 6 to ensure the availability and sustainable management of safe drinking water and sanitation for every individual [1]. The availability of water and its sustainable management are also related to the maintenance of basic human necessities and the guarantee of Food and Nutritional Security, which is affected by food safety and the lack of adequate water, sanitation, and hygiene facilities [2].

In Brazil, since 1977, the Ministry of Health has been responsible for the potability standard of water for human consumption, as well as defining the responsibilities and technical competencies of each organization of the Unified Health System (SUS) in the National Program for Water Quality Surveillance, known as Vigiagua [3]. It is essential to ensure that the supplied water meets the quality requirements for the uses for which it is intended. However, the Brazilian State of Rio de Janeiro faced two water supply crises during the pandemic of COVID-19, due to the presence of geosmin [4].

Geosmin and 2-methylisoborneol are organic compounds that can be synthesized by cyanobacteria, causing taste and odor in tap water. Many species of filamentous cyanobacteria, such as Anabaena, Planktithrix, Pseudanabaena (Planktonic), Phormidium, Oscillatoa and Lyngbya, have been confirmed as producers of geosmin and 2-MIB [5–8].

The presence of geosmin occurs due to the eutrophication of water springs, which contributes to the blooming of algae and cyanobacteria. In favorable environmental conditions, cyanobacteria show an accelerated growth, causing the phenomenon known as "bloom", with the appearance of stains on the water surface. Associated with this phenomenon is the production of compounds that confer taste and odor to water, such as MIB (1,2,7,7-tetramethylbicyclo-[2.2.1] heptan-2-ol, or simply 2-methylisoborneol) and geosmin (Trans-1,10-Dimethyl-trans-9-decalol) [6].

This "bloom", which promotes the increase of geosmin, due to the organic matter, is a result of the environmental pollution present in the river that supplies the city, by the untreated sewage load from the upstream cities. The Water Treatment Plant (WTP) of Guandu, located in Rio de Janeiro, belongs to the company responsible for supplying 16 cities and a population of 9 million inhabitants that are dependent on the Guandu System [6]. The main source of water supply in the metropolitan region of Rio de Janeiro, the Guandu River, passes through 15 towns until it flows into the Guanabara Bay, and it is the only source of water for subsistence and development in that region [3,9,10].

Many processes have been studied for the removal of these compounds; however, these approaches are costly and environmentally unsustainable for continuous use [11]. However, the Brazilian legislation does not determine the maximum permitted values for geosmin and 2-MIB in drinking water, as they are not associated with health problems, but there are standard limits described for taste and odor.

In April 2021, amid another crisis caused by geosmin, the water supply company (CEDAE) was divided for the concession of water and sewage distribution in four blocks of cities of Rio de Janeiro, including the capital, for 35 years.

It was privatized with the justification of ensuring the basic right to sanitation, since there is not even sanitation in many Brazilian cities. The sewage is in the open, causing various health problems, mainly due to poor quality water for residents, although the municipal plan of basic sanitation in the municipalities is required by law to ensure this right to the population. In addition, this concession may promote an increase in unemployment and tariffs related to the supply of water in the State of Rio de Janeiro [12].

The CEDAE auction raised R$22.6 billion with the sale of three of the four blocks offered [12] with the exception of Block 3, which includes the western zone of Rio de Janeiro and six other cities (Piraí, Rio Claro, Itaguaí, Paracambi, Seropédica and Pinheiral), an area of high concentration of peripheral neighborhoods. In addition, another problem in the west zone is the dumping of raw sewage that, after decades of neglect, is killing Sepetiba Bay, around which almost two million people live [13].

Therefore, in addition to the health crisis due to the COVID-19 pandemic, the State of Rio de Janeiro evidences the environmental and humanitarian crisis due to the water supply crisis. Thus, the aim of this study was to evaluate the perception of consumers regarding the quality of water in the State of Rio de Janeiro, during the COVID-19 pandemic.

## 2. Materials and Methods

An online survey was conducted, after approval by the Research Ethics Committee of the Federal University of the State of Rio de Janeiro (UNIRIO), No. 30994920.6.0000.5285, and the permission of the participants by signing the electronic Informed Consent Form (ICF), respecting the ethical aspects of the research.

The study took place from 26 to 30 April 2021, when the State of Rio de Janeiro counted 43,965 deaths due to the COVID-19 pandemic. People of both genders, aged 18 years or older, who were residents of the State of Rio de Janeiro, were invited to answer the survey. A total of 289 individuals participated in the survey. The Human Development Index (HDI) in Rio de Janeiro was 0.761 in the year 2019 [14]. However, it is important to stress that social inequality is high in the State of Rio de Janeiro, as well as throughout Brazil.

The survey was elaborated with closed questions on aspects related to access to drinking water and its quality, social isolation due to the new coronavirus pandemic, and socioeconomic data. The data were collected through the Google Forms platform, tabulated in the Excel® program, and analyzed by the software Epi Info 2002, through the Chi-Square test and $p < 0.05$ for statistical significance.

## 3. Results

Table 1 presents the results of the characterization of the research participants and classification regarding the social isolation practiced by individuals residing in the State of Rio de Janeiro.

**Table 1.** Characterization of individuals residing in the State of Rio de Janeiro and evaluation of drinking water consumption and economic aspects during the pandemic.

| Question | Answer | N | % |
|---|---|---|---|
| Gender | Female | 225 | 77.85 |
| | Male | 62 | 21.45 |
| | Undeclared | 2 | 0.69 |
| Region | Baixada Fluminense | 33 | 11.42 |
| | Rio de Janeiro | 256 | 88.58 |
| Education | Primary School I | 01 | 0.35 |
| | Primary School II | 03 | 1.04 |
| | Secondary School | 120 | 41.52 |
| | Higher Education | 59 | 20.42 |
| | Specialization | 43 | 14.88 |
| | Master's Degree | 42 | 14.53 |
| | Doctorate | 21 | 7.27 |
| Family income | ≥U$192.00 | 279 | 96.54 |
| | <U$192.00 | 11 | 3.46 |
| Age | 18 to 29 | 149 | 51.56 |
| | 30 to 39 | 61 | 21.11 |
| | 40 to 49 | 31 | 11.07 |
| | 50 to 65 | 41 | 14.19 |
| | ≥66 | 6 | 2.08 |
| Classification of social isolation measures adopted | Leaving home only when it is inevitable | 128 | 44.29 |
| | Being careful, but still leaving home | 146 | 50.52 |
| | Complete isolation | 6 | 2.08 |
| | Living normally, without changing the routine | 7 | 2.42 |
| Water quality | Indifferent | 56 | 19.38 |
| | Good | 116 | 40.14 |
| | Bad | 117 | 40.48 |
| Source of drinking water | Water treatment plant | 166 | 19.37 |
| | Mineral water | 84 | 29.07 |
| | Both | 189 | 13.49 |
| Treatment of the drinking water | Without treatment | 08 | 2.77 |
| | Filtered | 158 | 54.67 |
| | Simmered | 04 | 1.38 |
| | Mineral water | 78 | 26.99 |
| | Mineral and Filtered water | 41 | 14.19 |
| Spends on water | Yes | 239 | 82.70 |
| | No | 50 | 17.30 |
| Water costs have increased | Yes | 233 | 80.62 |
| | No | 2 | 0.69 |
| | Not applicable | 54 | 18.69 |
| During the pandemic there was a change in individual/family income | Yes, the income has decreased | 130 | 44.98 |
| | Yes, the income has increased | 24 | 8.30 |
| | No, the income remained the same | 135 | 46.71 |
| The drinking water and sanitation are considered a sustainability strategy | Yes | 256 | 88.58 |
| | No | 33 | 11.42 |
| Total | | 289 | 100 |

Most of the interviewees were female (77.85%), aged between 18 and 72 years old; 88.58% lived in the city of Rio de Janeiro and 11.42% in Baixada Fluminense, which comprises the most peripheral cities. Of those interviewed, 20.42% had completed higher education, 14.88% had a specialization and 21.80% had a master's or doctoral degree. As for income, 96.54% earned at least 192 dollars per month. Regarding isolation, 51.56% were

being careful but leaving home during the pandemic period, and 44.64% were leaving home only when necessary (Table 1).

Regarding the quality of the water, 40.83% evaluated the water as having no quality, 19.38% as regular and 39.69% as good for consumption. Furthermore, 42% used bottled mineral water, 36.33% used tap filter, 6.57% clay filter and 30.80% electric filter (Table 1).

Of the respondents, 80.28% reported having water expenses, and during the pandemic, for 80.62% there was an increase in water expenses. Regarding income, 44.98% reported a decrease of the income during the COVID-19 pandemic, and 88.58% of the respondents considered safe water and sanitation as a sustainability strategy (Table 1).

Table 2 shows the association between the variables studied, with an association between gender and perception of water quality, which was more evident for females ($p$ = 0.008). The quality of water supply directly influences the treatment of water by consumers, and it is evident that individuals who had high perception of low-quality water sought mineral water for daily consumption ($p$ = 0.000). Consumers who perceived poor water quality are those who classify water and sanitation as sustainability strategies ($p$ = 0.001). However, no association was found between the pandemic and the increase of water expenses ($p$ = 0.048), showing that the water crisis in Rio de Janeiro is chronic.

**Table 2.** Association of water quality with gender, region, age, family income, change in income during the pandemic, source of drinking water, treatment of drinking water, change in water expenses during the pandemic and drinking water and sanitation are considered a strategic sustainability issue.

| | | Quality of the Drinking Water | | | | | | Value of $p$ |
|---|---|---|---|---|---|---|---|---|
| | | Indifferent | | Good | | Bad | | |
| | | n | % | n | % | n | % | |
| Gender | Female | 44 | 15.22 | 79 | 27.34 | 102 | 35.29 | 0.008 |
| | Male | 12 | 4.15 | 35 | 12.11 | 15 | 5.19 | |
| | Undeclared | 0 | 0.00 | 2 | 0.69 | 0 | 0.00 | |
| Region | Baixada Fluminense | 8 | 2.77 | 11 | 3.81 | 14 | 4.84 | 0.631 |
| | Rio de Janeiro | 48 | 16.61 | 105 | 36.33 | 103 | 35.64 | |
| Family income | ≥U$192.00 | 2 | 0.69 | 4 | 1.38 | 4 | 1.38 | 0.999 |
| | <U$192.00 | 53 | 18.34 | 112 | 38.75 | 114 | 39.45 | |
| Age | 18 to 29 | 30 | 10.38 | 57 | 19.72 | 62 | 21.45 | 0.051 |
| | 30 to 39 | 6 | 2.08 | 33 | 11.42 | 22 | 7.61 | |
| | 40 to 49 | 5 | 1.73 | 14 | 4.84 | 13 | 4.50 | |
| | 50 to 65 | 12 | 4.15 | 10 | 3.46 | 19 | 6.57 | |
| | >66 | 3 | 1.04 | 2 | 0.69 | 1 | 0.35 | |
| Spends on water | Yes | 45 | 15.57 | 79 | 27.34 | 108 | 37.37 | 0.449 |
| | No | 11 | 3.81 | 37 | 12.80 | 9 | 3.11 | |
| Source of drinking water | Water treatment plant | 26 | 9.00 | 70 | 24.22 | 70 | 24.22 | 0.164 |
| | Mineral water | 24 | 8.30 | 29 | 10.03 | 31 | 10.73 | |
| | Both | 6 | 2.08 | 17 | 5.88 | 16 | 5.54 | |
| Treatment of the drinking water | Without treatment | 1 | 0.35 | 6 | 2.08 | 1 | 0.35 | 0.000 |
| | Filtered | 28 | 9.69 | 89 | 30.80 | 41 | 14.19 | |
| | Simmered | 1 | 0.35 | 1 | 0.35 | 2 | 0.69 | |
| | Mineral water | 21 | 7.27 | 9 | 3.11 | 48 | 16.61 | |
| | Mineral and Filtered water | 5 | 1.73 | 11 | 3.81 | 25 | 8.65 | |
| Water costs have increased | Yes | 7 | 2.42 | 7 | 2.42 | 9 | 3.11 | 0.481 |
| | No | 21 | 7.27 | 57 | 19.72 | 51 | 17.65 | |
| | Not applicable | 28 | 9.69 | 52 | 17.99 | 57 | 19.72 | |
| The drinking water and sanitation are considered a sustainability strategy | Yes | 42 | 14.53 | 109 | 37.72 | 106 | 36.68 | 0.001 |
| | No | 14 | 4.84 | 7 | 2.42 | 11 | 3.81 | |

## 4. Discussion

COVID-19 is an infectious disease and is caused by a newly discovered coronavirus that has spread rapidly around the world [15]. Transmission happens from one sick person to another or through close contact [16,17]. Due to the means of interpersonal transmission and the rapidity with which it spreads, several regions of the entire world have been

quickly affected, configuring what is known as a "global pandemic", a major challenge for the world [16,17].

In Brazil, the challenges are even greater due to the particularities found in the country, resulting from high social inequality, where the population finds itself without systematic access to water and in situations of low-income urban agglomerations, referred to as subnormal agglomerations (subnormal agglomerations are forms of irregular occupation of land owned by others—public or private—for housing purposes in urban areas and, in general, characterized by an irregular urbanistic pattern, lacking essential public services and located in areas with occupation restrictions [18]), known as "favelas" or communities, where many people live in precarious conditions, without access to health, social and financial support [19,20].

With the increase in the number of cases of infection and death from COVID-19, social distancing was seen as a non-pharmacalogical strategy [21,22], able to control the exponential growth of the disease, protecting health systems from collapse, due to demand far exceeding supply [19,23]. On the other hand, the distancing has strongly affected the lives of citizens, increasing social inequality, unemployment, hunger, and poverty [15,21].

In Brazil, transmission one year after the start of the pandemic is high, so distancing measures continue [15]. According to Bezerra et al. [24], this adherence may have something to do with the fear of becoming infected and suffering even greater health and financial losses.

In addition, the present study points out that 4% of the interviewees receive less than one minimum wage (US$ 192 dollars) per month, and more than 50% of the interviewees had decreased or maintained their income from before the pandemic. Therefore, the pandemic finds the Brazilian population in a situation of extreme vulnerability, with high rates of unemployment and deep cuts in social policies, in addition to the growing and intense throttling of investments in health and research in Brazil, triggered by the political crisis [19].

Along with all the crises experienced in Rio de Janeiro, Brazil, the hydric crisis has been evidenced [25]. It is known that water insecurity is measured by the irregular supply, or even the lack of drinking water, and reached, in 2020, 13.2% of households in the Southeast region of Brazil, where the State of Rio de Janeiro is located. The lowest rate of water insecurity is in the country, compared to the Northeast (40.2%) and North (38.4%) regions, but it is a reality that still exists in the region. It is also important to highlight the association between food insecurity and water insecurity. The proportion of households classified as suffering from serious food insecurity (hunger) doubles when there is no adequate availability of water for food production [26]. Among the conditions that increase the transmission of the SARS-CoV- 2 virus is greater home agglomeration, which occurs more frequently in households and in the poorer regions of the country.

On June 28th of 2021, the Minister of Mines and Energy at the time, Bento Albuquerque, made a statement on national television, affirming that the country is going through a water crisis and asked for a "conscious and responsible" use of water and energy by the population, since the last rainy season was the driest in 91 years [27]. This crisis directly impacts the lack of water for consumption, more expensive electricity bills and blackouts [26].

This water crisis is the result of a sum of factors related to water and sustainability, such as deforestation of the Amazon Forest; global warming caused by burning fossil fuels; and the natural phenomena La Niña [26,28–31]. On other occasions it was necessary to ration the water supply to minimize these impacts on the Brazilian population. In some regions of Brazil there was even a rotation of days with the water available in the cities, to save water.

The results of this study highlight the water crisis experienced by the State of Rio de Janeiro, resulting from the pollution of the Guandu River basin [25]. Of the interviewees, 40.83% reported that the drinking water coming from the water treatment plant has low

quality. Of those surveyed, 13.15% are from Baixada Fluminense and of those, 28.24% reported that the water that reaches their taps does not have good quality.

Water security deals directly with the pressures of global urban growth and its interference with water resources, which in turn affects sustainability and the protection of human health [31,32].

Problems with water supply are not recent. In 2015, the entire Southeast region of Brazil, including the State of Rio de Janeiro, experienced a water crisis; however, it is noteworthy that problems still experienced by the population nowadays are the lack of water or irregular supply (two or three times a week), particularly in less favored areas such as the Baixada Fluminense, showing the correlation between water and social crisis [33]. With the new sanitation decree, due to the approval of Law 14026/2020, which deals with the new Legal Framework for Basic Sanitation, water supply and sanitary sewerage services are under transformation in Brazil. The National Sanitation Plan and the new Sanitation Law set targets to bring the country closer to a universalization agenda for 2033. According to Law 14026/2020, the operating companies should serve 99% of the population with treated water and 90% with the collection and treatment of sewage [34].

Food systems are known to have an important role in promoting environmental sustainability, such as climate change adaptation and migrations, biological diversity and soil and water degradation [2]. Water stress in the water-abundant Latin American and Caribbean region has fueled several conflicts between various sectors, including agriculture, hydroelectricity, mining and even drinking water and sanitation. Water is universally underestimated and undervalued. Unfortunately, there are few governments, companies or citizens demanding that water should be valued.

## 5. Conclusions

Brazil is the fifth largest country in territorial size, with a population of over 210 million inhabitants. However, the current basic sanitation services are not provided to all Brazilians and a large part of the population has no access to sewage treatment. The National Basic Sanitation Plan established important goals and guidelines for the advancement of the levels of attendance of water and sewage services in Brazil. It is believed, however, that not enough has been invested in basic sanitation in the country, highlighting the need for reforms to increase investments and thus raise the coverage and quality of water and sewage services in Brazil.

It is suggested that these measures, combined with new technologies such as reused water, among others, can make potable water available for the entire Brazilian population, especially for the State of Rio de Janeiro, which again experienced one of the worst water crises. It is hoped that this research can be reproduced in other locations, considering the different realities and potentialities of each region.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

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